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October 21, 1968

Dr. Francis Crick
Waldorf Astoria Hotel
Park Avenue and 50th Street
New York, New York

Dear Francis:

Most of what I have enclosed is more political than technical. What follows is a summary of some technical points from the open literature.

1. Bacteria, rickettsia, fungi, viruses, and toxins have been examined for utility as weapons against humans, animals and crops. Most of what follows concerns BW against humans.

2. The most seriously considered mode of attack is by means of an aerosol cloud released by planes, drones, missiles, submarines or ships.

3. For infection to occur, particles must generally lodge in the deep recesses of the lungs. The optimal particle diameter for this purpose is 1-3 micra. About 50% of inhaled 2 micron particles lodge in the deep pulmonary spaces. Larger particles are filtered out in the upper respiratory tract where infection is generally unlikely to result. Above 10 micra the probability of deep penetration is extremely low. Most naturally occuring airborne bacteria and viruses reside on particles larger than 10 micra.

Below one micron the efficiency of retention in the lungs decreases and the particles are largely exhaled. However, below approximately 0.2 micra retention again becomes efficient.

4. Once released in the atmosphere, particles in the micron size range remain suspended for an average of at least a week. Thus a large portion of a military aerosol will travel for hundreds or thousands of kilometers before it is removed from the atmosphere. Particles in the micron size range remain suspended longer than larger ones which settle or smaller ones

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which impact more efficiently.

5. Aerosol clouds become diluted as they travel because of air turbulence at their boundaries. Experiments suggest that for long distance travel the horizontal spread is about one third of the distance traveled. Vertical spreading is limited by the tropopause. After a few hundred kilometers vertical spreading is more or less complete. The validity of these approximations is somewhat dependent on meteorological conditions.

6. Biological aerosols lose virulence and viability as they age. This has been studied at considerable length. You should see Bacteriological Reviews, volume 25, number 3 and volume 30, number 3 for extensive collections of papers presented at the "International Conferences on Aerobiology" largely organized by the U.S. Army Biological Laboratories. The important point is that certain aerosols retain their virulence for many hours, at least in the absence of sunlight. Even in the presence of sunlight I would expect that aerosols containing spores or certain viruses might be quite stable. Attempts are being made to produce microencapsulated aerosol particles. The encapsulation material would be chosen so as to facilitate aerosol production and maintain or enhance virulence under a variety of conditions.

7. A considerable number of organisms and viruses have been investigated as possible BW agents. The unclassified Army field manual on the employment of chemical and biological weapons suggests that several biological agents have now been standardized and are available as weapons. Reference is made both to lethal and to incapacitating biological agents. Incapacitating agents are defined as those intended to produce 2% or fewer deaths among total casualties. The unclassified manual refers to a second manual that is classified as secret and which presumably contains more detailed information. Some of the organisms and diseases on which Fort Detrick and Porton have reported are tularemia, Venezuelan equine encephalitis, yellow fever, anthrax, plaque, coccidioidomycosis, and Q fever. Rice blast and wheat rust have also been mentioned in the literature.

7. For military purposes it is desirable that only persons

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directly exposed to attack become infected. Contagious diseases are undesirable becuase they are especially difficult to predict and might infect friendly populations. Also reliance on contagion is to be avoided if a prompt effect is desired.

8. Aerosol attack would cause the pulmonary form of a given disease. Generally this is not the most commonly occuring form under natural conditions. The pulmonary form of a disease is generally more severe, more rapid in its development and more difficult to treat than other forms.

9. The number of organisms required to initiate infection depends upon a great number of factors. For some diseases under certain conditions a single inhaled organism is sufficient to initiate infection. In other cases, hundreds or even thousands of organisms are required. Considerable effor t has gone into studying the factors that influence the virulence of inhaled organisms.

10. A simple gas mask or perhaps just a wad of cotton held over the nose and mouth can provide very significent protection against the inhalation of biological aerosols. Various devices have been considered for providing warning of a biological attack but it is not clear to me if any of them is very good. In spite of statements to the contrary that have appeared in the press, I know of no nation that has made any very extensive provisions to protect its civilian population from biological attack.

My own feeling is that although biological weapons could kill or incapacitate very large numbers of people they would nevertheless be very poor weapons from a purely military point of view. Some of the reasons for this are as follows.

The use of BW obviously invites retaliation in kind, either at the time or in future conflicts.

Any nation making serious use of biological weapons would very likely be obliged to provide a defense against such weapons for its military and civilian population and perhaps for its allies. This could be very troublesome and expensive.

It would be very difficult to predict or control

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the effects of biological weapons in the field.

I am very apprehensive of any form of warfare that could become covert and insidious. If the traditional distinction between wartime and peacetime becomes blurred, the course of human civilization could be profoundly changed for the worse.

Biological weapons are likely to be far cheaper to produce and develop than other modern weapons, thus placing great destructive power in the hands of those not now possessing it.

For the above reasons, among others, it seems to me that it would be lunacy to use or even to threaten to use a biological weapon. I believe that any nation that projects an ambiguous attitude on this matter risks its own future security without obtaining any compensating benefits.

Even in emergencies so grave that national survival is at stake I do not see a rational use for biological weapons. Weapons powerful enough to threaten the existence of great powers cannot be neutralized by a preemptive biological attack. Missile launching sites and missile submarines are not vulnerable to biological weapons.

The above outline leaves out a number of interesting and important considerations. But together with the other materials I have enclosed it should be enough to indicate my general attitude about the subject.

I would like to see a copy of whatever you say or write about the subject. With best regards,

As ever,

Matt

Matthew Meselson

MM:wb
Enc.